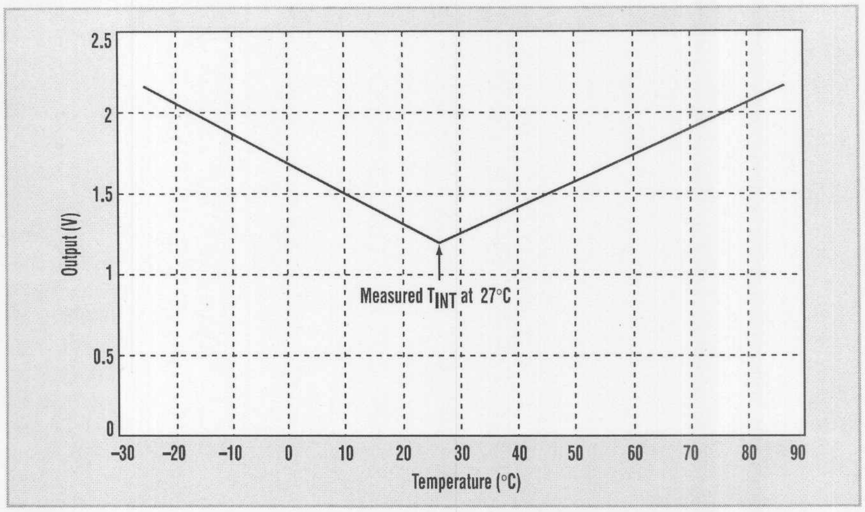
The values of R1 and R2 must therefore be selected such that

$$\frac{R_2}{\left(R_1 + R_2\right)} = \frac{V_{OS}}{V_{REF}} = \frac{0.728}{1.225} = 0.594 \tag{4}$$

I1 is determined by R1 and R2, and it should be set to significantly more than the quiescent current through the LM61 (125 μA max) in order to reduce errors caused by this quiescent current passing through R2. Choosing I1 to be 10 times greater than the quiescent current gives the condition:

$$\frac{1.225V}{\left(R_1 + R_2\right)} \geq 1.25mA \tag{5}$$



3. The measured V_{OUT} demonstrates the V-shaped curve used to approximate the actual parabolic curve of XT crystals.

Solving the two equations 4 and 5 for the two variables R1 and R2 results in the values R1 = 398 Ω and R2 = 582 Ω. The circuit in Figure 1 uses the standard resistor values of 360 Ω and 560 Ω to satisfy Equation 5 and gives a ratio of 0.636, very close to that of Equation 4.

Finally, R3 was selected so that I2 is within the operating range of the LM4041 voltage reference.

Figure 3 shows the output of the dual-slope temperature sensor circuit, measured over a temperature range of –25°C to 85°C. The average error over the full temperature range was 25.4 mV (approximately 2.5°C), and the maximum error was 46.4 mV (4.6°C).

Excel Formula Calculates Standard 1%-Resistor Values

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CIRCLE 521

The Excel cell formula below calculates the nearest standard 1%-resistor value without using a lookup table or macro. Type or electronically paste the text below into any cell (other than A1). The formula will calculate the nearest 1%-resistor for the value in cell A1. This formula can be copied and replicated to other cells just like any standard Excel cell formula.

A properly constructed spreadsheet used to calculate standard circuit values can produce more accurate designs. When calculating interdependent component values, standard resistor values can be used to calculate subsequent component values. This approach avoids a buildup of tolerance errors. Also, it will sometimes yield a more accurate design than if "perfect" calculated values are converted to nearest standard 1% values following the completion of all other calculations.

Mantissas of the 96-value-per-decade sequence are derived by

$$r = 10^{i/96} \quad \text{where } i = 0, 1, 2 \text{ to } 96$$

Each mantissa is then rounded to three significant digits, which creates small deviations from perfectly spaced values. The Excel formula calculates the two nearest standard values and tests them with the desired resistor value to select the closer.

```
=IF(A1>(INT(0.5+100*POWER(10,I
F(96*(LOG(A1)-INT(LOG(A1)))-
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)<0,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)-1,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0))/96)) *
POWER(10,INT(LOG(A1))-2) +
INT(0.5+100*POWER(10,(IF(96*(LO
G(A1)-INT(LOG(A1)))-
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)<0,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)-1,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0))+1)/96)) *
POWER(10,INT(LOG(A1))-2))/2,
INT(0.5+100*POWER(10,(IF(96*(LO
G(A1)-INT(LOG(A1)))-
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)<0,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)-1,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0))+1)/96)) *
POWER(10,INT(LOG(A1))-
2),INT(0.5+100*POWER(10,IF(96*(L
OG(A1)-INT(LOG(A1))) -
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)<0,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0)-1,
ROUND(96*(LOG(A1)-
INT(LOG(A1))),0))/96)) *
POWER(10,INT(LOG(A1))-2))
```

Note: Type this formula into the spreadsheet cell as a continuous entry without carriage returns.